IRTSS MODELING OF THE JCCD DATABASE

November 1998

Steve Luker
AFRL/VSBE
Hanscom AFB, MA 01731

And

Randall Williams
JCCD Center, US Army WES
Vicksburg, MS 39180-6199

ABSTRACT

AFRL developed Infrared Target-Scene Simulation Software (IRTSS) as a unit-level "through-the-sensor" infrared scene prediction capability to aid aircrews and mission planners in the employment of Precision Guided Munitions (PGMs). The system explicitly models the effects of weather, time-of-day, and mission tactics as viewed through the sensor and displayed on the weapon system display scopes. In addition, weapons system efficiency parameters such as detection and lock-on ranges are produced. AFRL has recently integrated a capability for modeling CCD-treated targets. Many simulation capabilities model CCD signatures, but few model target/CCD treatment interactions. IRTSS actually models the influence the target has on its CCD treatment (e.g., high thermal mass target under a camouflage net). This paper presents the preliminary results of an effort using IRTSS to model a particular field-test trial of the JCCD database. Using observed weather obtained through AFCCC and flight path information, IRTSS generated synthetic imagery that was compared to the JCCD mission video. Work ongoing involves using various metrics, human performance models, and photosimulation techniques to determine probability of detection (PD) for both the IRTSS synthetic imagery and the JCCD database imagery.

1.0 INTRODUCTION

The Infrared Target Scene Simulation System [IRTSS] has been developed by AFRL/VSBE to produce synthetic infrared (ir) scene predictions for use by military aircrews and weapons system operators. IRTSS is a physics-based modeling package requiring four primary components (geographic backgrounds, targets, atmospheric effects, and sensor effects) to generate synthetic 8-12 micron ir imagery.

Geographic backgrounds are typically derived from multi-spectral satellite imagery that describe the distribution of material types on the earth surface, however, other sources such as aerial photography or digitized vector data can also be used. A target generator allows fully customizable targets (figure 1) using 3-D geometry's (created by CAD systems) and user-defined target-surface materials. Signal propagation through the atmosphere is accomplished using a MODTRAN interpolator, and automated weather feeds such as AWDS and AFWIN and/or user-defined weather observations provide the necessary meteorological inputs. Sensor effects are predicted using a sensor performance model which simulates sensor parameters such as gain, level, and field-of-view. Surface temperatures are calculated using recent

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)
01-11-1998

2. REPORT TYPE
Conference Proceedings

3. DATES COVERED (FROM - TO)
xx-xx-1998 to xx-xx-1998

4. TITLE AND SUBTITLE
IRTSS Modeling of the JCCD Database
Unclassified

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Luker, Steve ;
Williams, Randall ;

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME AND ADDRESS
AFRL/VSBE
Hanscom AFB, MA01731

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS
Director, CECOM RDEC
Night Vision and Electronic Sensors Directorate
10221 Burbeck Road
Ft. Belvoir, VA22060-5806

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APUBLIC RELEASE
,

13. SUPPLEMENTARY NOTES
See Also ADM201041, 1998 IRIS Proceedings on CD-ROM.

14. ABSTRACT
AFRL developed Infrared Target-Scene Simulation Software (IRTSS) as a unit-level "throughthe- sensor" infrared scene prediction capability to aid aircrews and mission planners in the employment of Precision Guided Munitions (PGMs). The system explicitly models the effects of weather, time-of-day, and mission tactics as viewed through the sensor and displayed on the weapon system display scopes. In addition, weapons system efficiency parameters such as detection and lock-on ranges are produced. AFRL has recently integrated a capability for modeling CCD-treated targets. Many simulation capabilities model CCD signatures, but few model target/CCD treatment interactions. IRTSS actually models the influence the target has on its CCD treatment (e.g., high thermal mass target under a camouflage net). This paper presents the preliminary results of an effort using IRTSS to model a particular field-test trial of the JCCD database. Using observed weather obtained through AFCCC and flight path information, IRTSS generated synthetic imagery that was compared to the JCCD mission video. Work ongoing involves using various metrics, human performance models, and photosimulation techniques to determine probability of detection (PD) for both the IRTSS synthetic imagery and the JCCD database imagery.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:

a. REPORT	b. ABSTRACT	c. THIS PAGE
Unclassified	Unclassified	Unclassified

17. LIMITATION OF ABSTRACT
Public Release

18. NUMBER OF PAGES
5

19. NAME OF RESPONSIBLE PERSON
Fenster, Lynn
lfenster@dtic.mil

19b. TELEPHONE NUMBER
International Area Code
Area Code Telephone Number
703767-9007
DSN
427-9007

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39.18

weather history by modeling solar energy input, convective heat loss etc. The result is a synthetic scene that predicts what is likely to appear on a weapons system display scope, given current or forecast weather conditions.

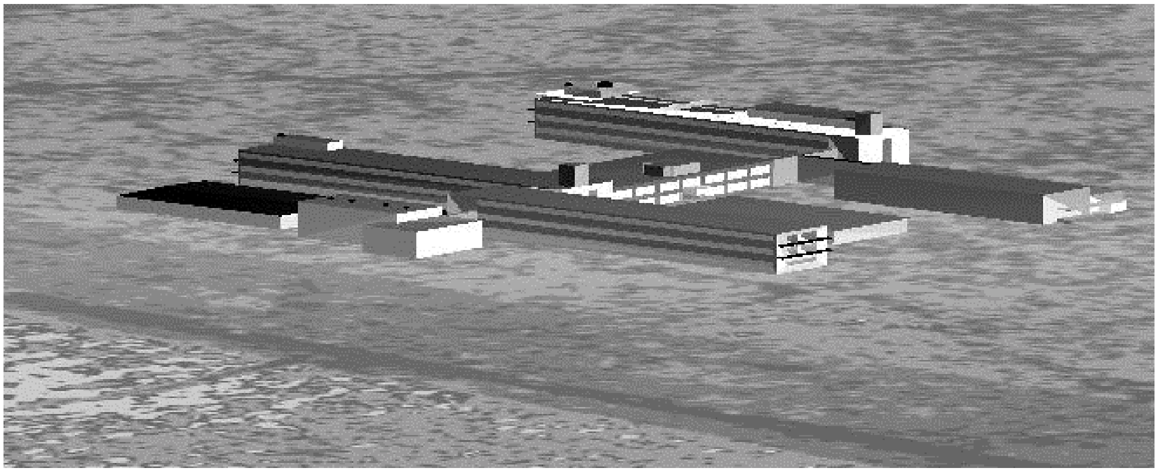

Figure 1. Target building software allows fast and accurate customization of complex targets.

The JCCD database is a comprehensive well-documented database containing 8-12 micron ir mission video of over 3000 target approaches flown against various levels of camouflage, concealment, and deception (CCD). IRTSS has recently integrated a CCD modeling capability to predict and visualize targets under camouflage netting. This paper will focus on the JCCD modeling effort in IRTSS and will illustrate some of the preliminary synthetic scenes which simulate a particular test-cell of the JCCD database.

2.0 RESEARCH ACCOMPLISHED

Although the IRTSS framework is extremely conducive to CCD modeling in the ir, this was the first attempt to integrate such an effort into the IRTSS visualization component. There were several requirements for this effort including surveying the JCCD database for a simple “first attempt” candidate, generating backgrounds and targets, developing a camouflage net model, reconstructing the actual scenario, and integrating everything into the modeling and visualization components of IRTSS.

The JCCD database contains several test-cells, each varying in both the number and complexity of targets and CCD treatments for those targets. For the first attempt a small isolated target near the B-12 test range at Eglin Air Force Base with a simple homogenous background was chosen. This was thought to represent the least complex test-cell of the JCCD database, which satisfied the first requirement. The small isolated target test-cell consisted of a TBM launcher located on a narrow dirt road surrounded by mostly coniferous scrub pine (figure 2). Three types of CCD treatment were used on this target: 1) baseline (no CCD), 2) camouflage netting, and 3) camouflage netting over primary target with decoy.

Figure 2. Small isolated target (under the camouflage net) on dirt road with pine tree background.

Geographic backgrounds were created from high-resolution (1-meter) aerial color infrared digital orthophotographs. Separate scanning of red, green and near-ir bands allowed the derivation of several surface material categories, the majority of which was coniferous scrub pine, sand, clay, and grass. Both the TBM launcher and decoy targets were generated using the IRTSS target builder based on the descriptions provided in the JCCD database.

Two approaches were used (both empirical and physics-based) in developing a camouflage net model that could be visualized in IRTSS. Mission video and field measurements suggested that the camouflage net allowed small varying degrees of "thermal bleeding" to occur from the target through the net. This empirical approach captured the "thermal bleeding" (figure 3) by assigning the net temperature equal to the air temperature and fluctuating the opacity of the net. In addition, the synthetic net was "textured" using image data from real ir net imagery. This gave a more photorealistic look. Flexibility in the target builder allowed for a physics-based approach. In creating the CAD geometry for the target, a separate net target was added (figure 4) to become an integrated TBM launcher under a camouflage net as a single target. The target builder used a convection model to determine the net's temperature, however, the problem with determining the correct opacity for rendering was still apparent (figure 5).

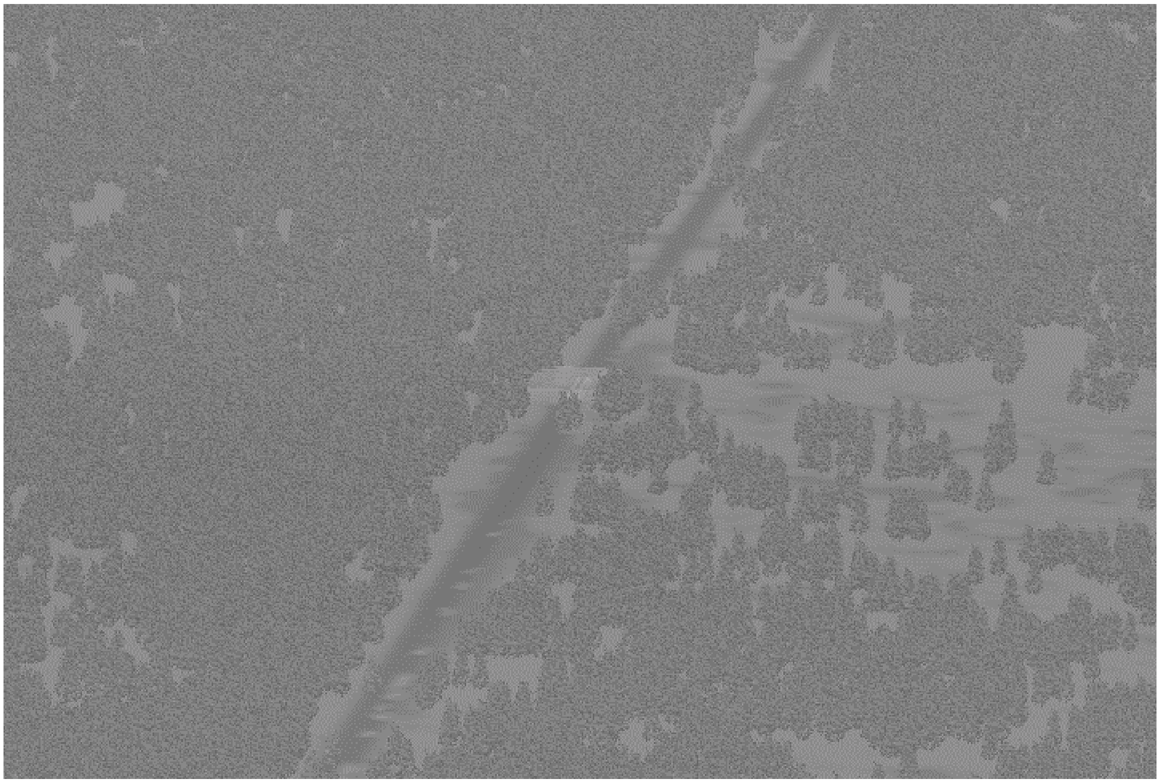

Figure 3. IRTSS generated synthetic ir scene of TBM launcher under camouflage net. The thermal signature of the missile (black line in the center) can be seen "bleeding through" the camouflage net.

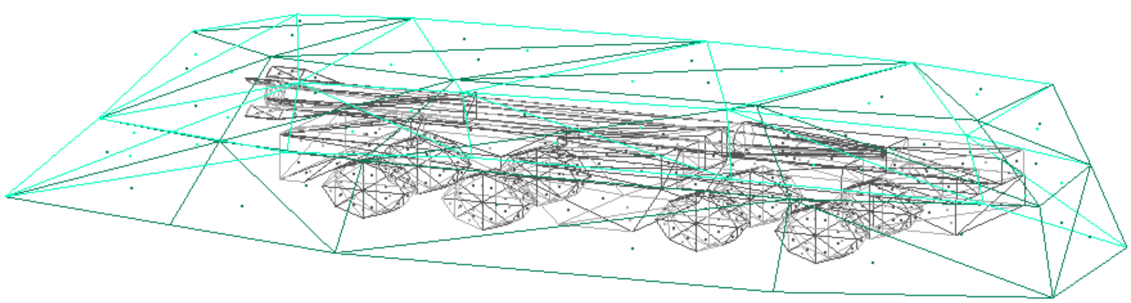

Figure 4. The TBM launcher and net represented as an integrated target generated with the target builder.

The JCCD database provided many of the necessary parameters (e.g., time of day, approach heading and attack altitude) needed to reconstruct and set up the scenario for running IRTSS, although, some of these parameters were not provided in sufficient detail. For example, the JCCD database did record observed weather for the time of flight, however, IRTSS needed 24 hours of past weather history to initialize the models. Consequently, archived weather data provided by AFCCC was parsed and converted into a readable format for IRTSS. Similarly, the flight profile was reconstructed from mission video waypoints to represent a "typical" sortie approach. Although the target approaches held close to a set heading, reconstruction of waypoints was compounded by the WSOs ability to slew the sensor in all directions to look for targets.

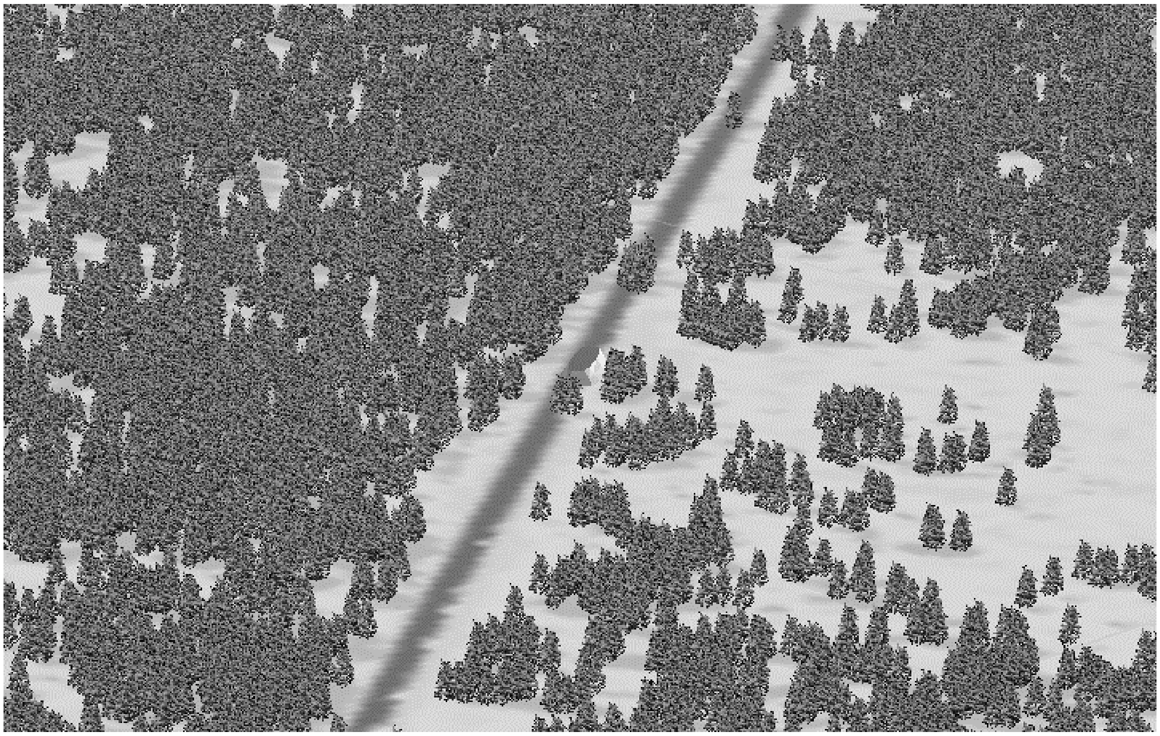

Figure 5. Camouflage net model using physics-based target builder. There is no "thermal bleeding" or net texturing.

IRTSS generated a sequence of synthetic scenes approaching the target. The synthetic scenes were visually compared to the mission video. This paper is UNCLASSIFIED, therefor it's content does not show the comparisons with the mission video. However, there were many visual similarities, although no actual image-to-image validation was performed. Figures 3 and 5 are representative samples of the IRTSS synthetic scenes. The accompanying briefing has a video segment which will show the IRTSS synthetic images versus JCCD mission video.

3.0 CONCLUSIONS AND RECOMMENDATIONS

This goal of this effort was to illustrate a proof of concept and to begin the initial stages of integrating a CCD modeling capability into IRTSS. Certainly, there is a considerable amount of validation that needs to be performed before this capability can generate and render CCD-treated targets with great confidence. However, the applicability and utility of this type of technology in the intelligence, targeting and mission planning communities is quite obvious. Further model development and testing against the JCCD database are absolutely necessary to mature this capability. No other database of ir sorties against CCD-treated targets exists in sufficient credibility and numbers for validation of modeling. Consequently, the contents of the JCCD database should be exploited as at least a baseline for modeling and simulation of sensor-to-shooter CCD-treated targets.